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Q.NO.1

- Why is geology essential when it comes to the domain of civil engineering? Analyze the involvement of Geology in all the aspects of a construction project?

(Ans) Involvement of Geology in Civil Engineering:

- In civil engineer faces a variety of problems, in which the knowledge of geology is necessary. Undoubtedly learn more geology in the field and in practice than can teach in the classroom or in the laboratory of a school. But this learning will be easier and faster and more effective implementation, if included basic principles of geology in engineering courses. Especially deserve mention some advantages specifies which some pause to develop it further through work. Systematized knowledge of materials. The problems are essentially geological foundation. The buildings, bridges, dams, and other structures are set on a natural material. The excavations can be planned and run smarter and more safely performed. Knowledge of the existence of groundwater, and groundwater hydrology elements are excellent aids in many branches of engineering practice. Knowledge of surface water, the effects of erosion, transport and sedimentation, is essential for the control of currents, the work of defending margins and costs of soil conservation and other activities. The ability to read and interpret geological maps, geological maps and topographic information and photography, is useful for the planning of many works. Training to recognize the nature of geological problems.
- Most civil engineering projects involve some excavation of soils and rocks, or involve loading the Earth by building on it.
- In some cases, the excavated rocks may be used as constructional material, and in others, rocks may form a major part of the finished product,
- Such as a motorway cutting or
- The site for a reservoir
- The feasibility, the planning and design, the construction and costing, and the safety of a project may depend critically on the geological conditions where the construction will take place.
- This is especially the case in extended “greenfield” sites, where the area affected by the project stretches for kilometers, across comparatively undeveloped ground.
- Examples include the Channel Tunnel project and the construction of motorways. In a section of the M9 motorway linking Edinburgh and Sterling that crosses abandoned oil-shale workings, realignment of the road, on the advice of government geologists, led to a substantial saving. In modest projects, or in those involving the redevelopment of a limited site, the demands on the geological knowledge of the engineer or the need for geological advice will be less, but are never negligible. Site investigation by boring and by testing samples may be an adequate preliminary to construction in such cases.

Involvement of Geology in all the aspects of a construction project:

- In all type of heavy construction like building tower, dams, reservoirs, highways, bridges, traffic and hydropower tunnel and retaining structure. The geological information about the site of construction (or excavation) and about the natural materials of construction is of paramount importance. This information is vital for planning realistic and designing and economic excavation of one and all of such projects.

Planning:

- It provides the engineer with a general guidance about the suitability of the site for a proposed project.
- It enables the engineer to appreciate the limiting factors imposed upon his planning by topography, geomorphology, and ground water conditions etc. of the area.
- It gives the engineer a general idea about the availability of different types of construction material.
- It guides him in limiting the exploratory operation (Drilling) for selecting the final site to such number as would be absolutely essential.

Designing:

- The existence of hard rock and their depth from an inclination with the surface.
- Mechanical properties of the rocks along the proposed site, especially, bearing strength, shear strength, modulus of elasticity, permeability and resistance to decay and disintegration.
- Presence of structurally weak plans (joints, faults and fractures) and weak zones (peat deposits and sheared zones) especially at critical regions of a site selected for the project.

In Town and Regional Planning:

- The major factor in town planning is the allocation of site for industrial site is dependent on the geomorphology of the region.
- It helps the town planner in allocating the space for the building with respect to FSI.
- During the formation of city the design prepared for the drainage and drinking water should not coincide with each other.
- The study of the water cycle is an essential section for planning and execution of a major water level program.

The value of geology in Mining has long been known but its use in Civil Engineering has been recognized only in comparatively recent years. The importance of geology in civil engineering may briefly be outlines as follows,

- Geology provides a systematic knowledge of construction material, its occurrence, composition, durability and other properties. Example of such construction materials is building stones, road metal, clay, limestone and laterite.
- The knowledge of the geological work of natural agencies such as water, wind, ice and earthquakes helps in planning and carrying out major civil engineering

works. For example the knowledge of erosion, transportation and deposition helps greatly in solving the expensive problems of river control, coastal and harbor work and soil conservation.

- Ground water is the water which occurs in the subsurface rocks. The knowledge about its quantity and depth of occurrence is required in connection with water supply, irrigation, excavation and many other civil engineering works.
- The foundation problems of dams, bridges and buildings are directly concerned with the geology of the area where they are to be built. In these works drilling is commonly undertaken to explore the ground conditions. Geology helps greatly in interpreting the drilling data.
- In tunneling, constructing roads, canals, docks and in determining the stability of cuts and slopes, the knowledge about the nature and structure of rocks is very necessary.
- Before staring a major engineering project at a place, a detailed geological report which is accompanied by geological maps and sections, is prepared. Such a report helps in planning and constructing the projects.
- The stability of civil engineering structure is considerably increased if the geological feature like faults, joints, bedding planes, folding solution channels etc. in the rock beds are properly located and suitably treated.
- In the study of soil mechanics, it is necessary to know how the soil materials are formed in nature.
- The cost of engineering works will considerably reduce of the geological survey of the area concerned is done before hand.

Q.NO.2:

a. **Give some possible reasons of post-volcanic changes:**
    - **Post-volcanic changes:**
        - The gases with which the magma is charged are slowly dissipated, lava flows often remain hot and steaming for many years.
        - These gases attack the components of the rock and deposit new minerals in cavities and fissures.
        - Even before these “post-volcanic” processes have ceased,
            - Atmospheric decomposition or weathering begins as the mineral components of volcanic and igneous rocks are not stable under surface atmospheric conditions.
            - Rain, frost, carbonic acid, oxygen, and other agents operate continuously, and do not cease until the whole mass has crumbled down and most of its ingredients have been resolved into new products or carried away in aqueous solution.

b. **Explain how the amount of SiO2 ultimately effects the composition of igneous rocks?**
   - **Composition of Igneous Rocks Ultimately Effect by the Amount of SIO_2:**
     - Igneous rocks are commonly classified by their composition and texture. Most are composed of the eight most abundant elements in the earth's crust. Because of the dominance of oxygen and silicon in the crust, igneous rocks are mostly made up of silicate minerals. These silicates can be generally divided into light and dark silicates. The dark silicates are also called ferromagnesian because of the presence of iron and magnesium in them. They include olivine, pyroxene, amphibole and biotite. The light-colored silicates include quartz muscovite and feldspar.
     - Felsic and mafic rocks, division of igneous rocks on the basis of their silica content. Chemical analyses of the most abundant components in rocks usually are presented as oxides of the elements; igneous rocks typically consist of approximately 12 major oxides totaling over 99 percent of the rock. Of the oxides, silica (SiO_2) is usually the most abundant. Because of this abundance and because most igneous minerals are silicates, silica content was used as a basis of early classifications; it remains widely accepted today. Within this scheme, rocks are described as felsic, intermediate, mafic, and ultramafic (in order of decreasing silica content).
     - In a widely accepted silica-content classification scheme, rocks with more than 65 percent silica are called felsic; those with between 55 and 65 percent silica are intermediate; those with between 45 and 55 percent silica are mafic; and those with less than 45 percent are ultramafic. Compilations of many rock analyses show that rhyolite and granite are felsic, with an average silica content of about 72 percent; syenite, diorite, and monzonite are intermediate, with an average silica content of 59 percent; gabbro and basalt are mafic, with an average silica content of 48 percent; and peridotite is an ultramafic rock, with an average of 41 percent silica. Although there are complete gradations between the averages, rocks tend to cluster about the averages. In general, the gradation from felsic to mafic corresponds to an increase in color index (dark-mineral percentage).
     - The fine-grained or glassy nature of many volcanic rocks makes a chemical classification such as the felsic-mafic taxonomy very useful in distinguishing the different types. Silica content is especially useful because the density and refractive index of natural glasses have been correlated with silica percentage; this makes identification possible in the absence of chemical data. For similar determinations, glasses can also be prepared in the laboratory from crystalline rocks.
     - The influence of silica content on the particular minerals that crystallize from a rock magma is a complex interaction of

several parameters, and it cannot be assumed that rocks with the same silica content will have the same mineralogy. Silica saturation is a classification of minerals and rocks as oversaturated, saturated, or under saturated with respect to silica. Felsic rocks are commonly oversaturated and contain free quartz (SiO_2), intermediate rocks contain little or no quartz or feldspathoids (under saturated minerals), and mafic rocks may contain abundant feldspathoids. This broad grouping on the basis of mineralogy related to silica content is used in many modern classification schemes.

Q.NO.3:

- **Why does weathering occur? Make a comparative analysis of different forms of weathering.**

    - **Weathering Occur:**
      Weathering is the breakdown of rocks and minerals “in situ,” meaning it occurs without major movement of the rock materials. Weathering happens through processes or sources in the environment, including events like wind and objects like the roots of plants. Weathering is either mechanical, in which rocks are broken down through an external force, or chemical, which means rocks are broken down through a chemical reaction and change.
      Weathering occurs when the appearance or texture of an object (generally rock) is worn down by exposure to the atmosphere. This can occur due to either chemical decomposition or physical disintegration. While weathering usually occurs on the earth’s surface, it can also happen far beneath, where for example, groundwater percolates through fractures in the bedrock. It is important to note that for weathering rather than erosion to have occurred, the object being acted upon must remain stationary. While there are many causes of weathering, there are four that are by far the most common.

Causes of Weathering Occurs:

1. **Frost Weathering:**
    - ✓ Frost weathering occurs in the presence of water, particularly in areas where the temperature is near the freezing point of water. Water freezes at 32 degrees Fahrenheit, or 0 degrees Celsius. This is particularly common in Alpine areas and around the edges of glaciers. When water freezes, it expands, so when liquid water seeps into a crevice in the rock or soil and freezes, its expansion can cause deeper cracks in the rock and eventually break pieces off.
2. **Thermal Stress:**
    - ✓ Thermal stress occurs when heat absorbed from the surrounding air causes a rock to expand. This expansion, and the subsequent contraction when the rock eventually cools, can cause thin sheets of the rock's outer layer to peel off. While changes in temperature are the principal driver of thermal stress

weathering, moisture can play a part here as well. This process is often found in desert areas, where temperatures vary greatly between day and night.

3. **Salt Wedging:**
    - ✓ Like frost weathering, salt weathering is caused by water. Water can get into the rock in a number of ways. Common ways are up from a groundwater supply, through the action of seawater waves along a rocky coast, or downward through traditional rainfall. Unlike frost weathering, in this case the water evaporates, leaving behind salt, which eventually forms into crystals. The growing crystals can exert a pressure on the rock that eventually breaks it.
4. **Biological Weathering:**
    - ✓ When plants and animals weather rocks, the process is called biological weathering. Biological weathering occurs when plants break up rocks with roots, prying the rock apart. When burrowing animals, such as badgers, moles and rabbits, burrow into rocks in search of shelter or food, this is considered biological weathering as well.

- **Comparative analysis of different forms of weathering:**
    - **Physical/Mechanical Weathering:**
    - ➢ Mechanical weathering is also known as physical weathering. Mechanical weathering is the physical breakdown of rocks into smaller and smaller pieces. One of the most common mechanical actions is frost shattering. It happens when water enters the pores and cracks of rocks, then freezes. Frost weathering, frost wedging, ice wedging or cry fracturing is the collective name for several processes where ice is present. These processes include frost shattering, frost-wedging and freeze-thaw weathering.
    - ➢ Once the frozen water is within the rocks, it expands by about 10% thereby opening the cracks a bit wider. The pressure acting within the rocks is estimated at 30,000 pounds per square inch at -7.6°F. Over time, this pressure alongside the changes in weather makes the rock split off, and bigger rocks are broken into smaller fragments.
    - ➢ Another type of mechanical weathering is called salt wedging. Winds, water waves, and rain also have an effect on rocks as they are physical forces that

wear away rock particles, particularly over long periods of time. These forces are equally categorized under mechanical or physical weathering because they release their pressures on the rocks directly and indirectly which causes the rocks to fracture and disintegrate.

- Mechanical/physical weathering is also caused by thermal stress which is the contraction and expansion effect on the rocks caused by changes in temperature. Due to uneven expansion and contraction, the rocks crack apart and disintegrate into smaller pieces.

- **Organic/Biological Weathering:**

- Organic or biological weathering refers to the same thing. It is the disintegration of rocks as a result of the action by living organisms. Trees and other plants can wear away rocks since as they penetrate into the soil and as their roots get bigger, they exert pressure on rocks and makes the cracks wider and deeper. Eventually, the plants break the rocks apart. Some plants also grow within the fissures in the rocks which lead to widening of the fissures and then eventual disintegration.

- Microscopic organisms like algae, moss, lichens and bacteria can grow on the surface of the rocks and produce chemicals that have the potential of breaking down the outer layer of the rock. They eat away the surface of the rocks. These microscopic organisms also bring about moist chemical micro-environments which encourage the chemical and physical breakdown of the rock surfaces. The amount of biological activity depends upon how much life is in that area. Burrowing animals such as moles, squirrels and rabbits can speed up the development of fissures.

- **Chemical Weathering:**

- Chemical weathering happens when rocks are worn away by chemical changes. The natural chemical reactions within the rocks change the composition of the rocks over time. Because the chemical processes are gradual and ongoing, the mineralogy of rocks changes over time thus making them wear away, dissolve, and disintegrate.

- The chemical transformations occur when water and oxygen interacts with minerals within the rocks to create different chemical reactions and compounds through processes such as hydrolysis and oxidation. As a result, in the process of new material formations, pores and fissures are created in the rocks thus enhancing the disintegration forces.

- Rainwater can also at times become acid when it mixes with acidic depositions in the atmosphere. Acid depositions are created in the atmosphere as a consequence of fossil fuel combustion that releases oxides of nitrogen, sulfur and carbon.

- The resultant acid water from precipitation – (acid rain) reacts with the rock's mineral particles producing new minerals and salts that can readily dissolve or wear away the rock grains. Chemical weathering mostly depends on the rock type and temperature. For instance, limestone is more prone to chemical erosion compared to granite. Higher temperatures increase the rate of chemical weathering.